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Evaluation of Radionuclide Concentrations in Drinking Water level of Dennis Osadebay University, Asaba, Delta State

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Abstract

Potassium (^{40}K), Uranium (^{238}U) and Thorium (^{232}Th) are radionuclides that are present in drinking water sources naturally or artificially. The exposure of humans and animals to these radionuclides in minute doses may cause chronic health issue in future. This work analyzed the level of activity concentrations Potassium, Uranium and Thorium (^{40}K, ^{238}U and ^{232}Th) in borehole water use for drinking and other domestic activity. Twenty-nine (29) samples were collected in a one-liter cylindrical air tight polyvinylchloride containers thoroughly washed and sterilized. The samples were analyzed using a well calibrated thallium activated 3x3 Sodium Iodide NaI(Tl) detector at the Institute of Radiation Protection and Research (NIRPR). The results of the analyses showed that the activity concentration of ^{40}K, ^{238}U and ^{232}Th have mean values of 110.39 ± 19.21, 9.35 ± 2.01, and 5.21 ± 2.56, respectively were all above the world average recommended values of WHO and UNSCEAR. Therefore, the use of the water for drinking is toxic and detrimental to the physiology and the overall health status of the consumers.

Keywords: Radionuclide, borehole water, health, activity concentration

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Introduction

Water is generally present in living and non-living component in the environment. It is known that 75 percent of the earth surface is covered by water. Water is a major nutrient that makes it possible for plant to carryout photosynthesis. All animals including human need water to survive. Water needed by the body of plant and animals must be free from toxicants in whatever state such as solid, particulates, liquid or gas and radionuclides [1]. In the aquatic environment, industrial and natural activities result in the deposition of radionuclides into rivers, lakes and dams, where they are absorbed by fish through both direct contact with contaminated water and through the food chain, as smaller organisms ingest radionuclides that are then consumed by bigger fish [2]. Radionuclides are ubiquitous in the aquatic environment such as lake, river, stream etc because they can be detected in fishes, water and the sediment of the aquatic environment [3, 4]. Radionuclides are chemical elements with unstable isotopes that emit ionizing radiation as they decay. These isotopes, known as radioactive isotopes, have finite lifetimes ranging from mere fractions of a second to thousands of years [3]. The decay process releases three main types of radiation: alpha particles (α), beta particles (β), and gamma rays (γ) [5].

Ground wateruse as a primary source of drinking and domestic purpose by local communities maybe exposed to radioactive contaminants [1, 6, 7]. The taking in of water containing radionuclides can lead to internal exposure that may result to radiation-induced illnesses like cancers and other chronic health conditions [8, 9] and bone cancer, leukemia, and kidney disorders [10]. The radionuclides such as ^{40}K, ^{238}U and ^{232}Th are of particular interest because of their potential to cause chronic radiological health effects when present in increased concentrations [6, 11]. It is of utmost importance for the benefit of humans and animals health to know the concentration of radionuclides in drinking water and aquatic water body. Thus, it is necessary to analyze the level of concentration of radionuclides in different part of our country Nigeria. Some workers [10, 12] reported the presence of radionuclides in ground water in a gold mine pit in Gombe, Nigeria and the chronic health implication that may result over a period of time. This work duels on the activity concentration of ^{40}K, ^{238}U and ^{232}Th in borehole water in Dennis Osadebay University Asaba, Delta State as a case study in the state.

Materials and Methods

Study area

Dennis Osadebe University is a prominent public institution located in Asaba, Delta State, Nigeria. Established to foster academic excellence and personal development. Geographically, Dennis Osadebe University occupies a strategic position in the southern region of Nigeria. The university is situated at approximately 6.2346°N latitude and 6.6936°E longitude, placing it within reach of both major cities and serene natural surroundings. This ideal location offers students not only the advantages of urban amenities but also the tranquility necessary for focused study and creativity. Fig. 1 represents the map of the study area.

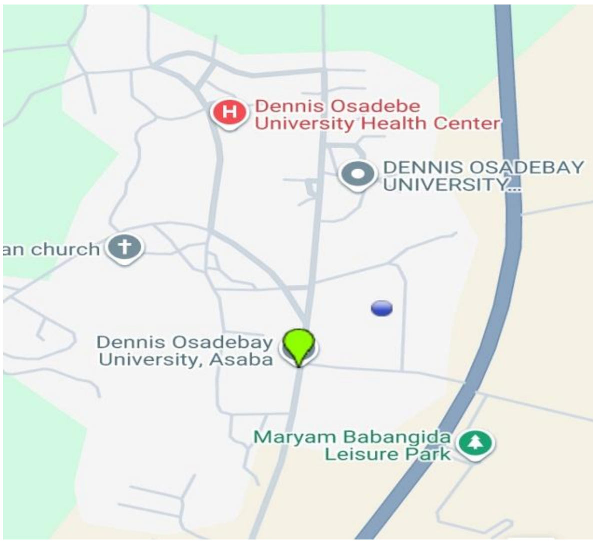

Figure 1: Map of the study area

Twenty-nine (29) were collected from different boreholes water sources within the perimeter of Dennis Osadebe University, Asaba Delta State and is use for drinking and other domestic activities. Standard methods were used in the collection of the samples. At the point of sample collection, water samples were collected in cylindrical air tight polyvinylchloride containers and thoroughly washed with dilute HNO_3, rinsed with distilled water and kept for at least 28 days so that the radionuclides in them can attain secular equilibrium. All the water samples were labeled properly, to avoid cross contamination. After secular equilibrium was attained, the gamma spectrometry measurements of the samples were carried out using a well calibrated thallium activated 3x3 Sodium Iodide NaI(Tl) detector at the Institute of Radiation Protection and Research (NIRPR), University of Ibadan, Nigeria.

The specific activity of the radionuclide in each water sample was calculated using the expression [13]

$$C = \frac{A}{V_\gamma \, T E_p} \quad \text{..............................} \quad (1)$$

where C = specific activity of the radionuclide in Bqkg^{-1}, A = Net area under the photo peak of each radionuclide, V_γ = Volume of water sample, T = Counting time, E_p = Efficiency at specific gamma ray energy in Bqkg^{-1}.

Results and Discussion

Table 1 presented the results of the radionuclide analysis of ^{40}K, ^{238}U and ^{232}Th of borehole water, sampled in DOU. The results were comparative with the United Nations Scientific Committee (UNSCEAR) acceptable concentration level of the radionuclides in drinking water [14].

Table 1: The entire activity concentration of the radionuclides in the borehole water samples from the study area (Bq L^{-1})

S/N	Sample Code		^{40}K	^{238}U	^{232}Th
1	Dou BH1	Health Center	99.80 ± 15.31	7.34 ± 4.12	4.56 ± 1.32
2	Dou BH2	Up Hill	98.99 ± 22.09	9.59 ± 3.70	5.98 ± 2.11
3	Dou BH3	New Site	98.49 ± 14.58	11.34 ± 2.94	6.14 ± 2.09
4	Dou BH4	Council	189.01 ± 21.29	9.35 ± 2.10	6.79 ± 3.00
5	Dou BH5	Girls Hostel	102.75 ± 17.31	8.78 ± 1.86	5.63 ± 2.16
6	Dou BH6	New Agric Farm	82.13 ± 23.60	6.76 ± 1.11	4.20 ± 2.03
7	Dou BH7	New Girls Hostel	127.18 ± 24.01	8.32 ± 2.98	7.21 ± 3.04
8	Dou BH8	ICT	94.41 ± 13.39	9.38 ± 1.89	9.08 ± 2.33
9	Dou BH9	Cooperative	128.01 ± 23.78	9.98 ± 1.98	7.78 ± 3.01
10	Dou BH10	Agric	168.74 ± 15.06	8.57 ± 2.09	6.89 ± 1.51
11	Dou BH11	Administration	99.80 ± 15.31	7.34 ± 2.12	5.56 ± 1.02
12	Dou BH12	BH Science	98.99 ± 22.09	9.59 ± 3.70	4.98 ± 1.11
13	Dou BH13	Library	110.84 ± 14.18	8.34 ± 2.94	6.14 ± 2.09
14	Dou BH14	Ang Church	189.01 ± 31.29	10.56 ± 2.10	8.79 ± 3.00
15	Dou BH15	Boy Hostel	102.75 ± 31.86	11.78 ± 3.86	9.43 ± 2.16
16	Dou BH16	FOM	98.21 ± 16.00	6.76 ± 2.11	4.20 ± 1.38
17	Dou BH17	FOS	132.71 ± 18.40	7.32 ± 1.78	5.02 ± 2.04
18	Dou BH18	Ogbogo	98.44 ± 13.90	11.38 ± 1.89	9.98 ± 2.33
19	Dou BH19	FOA	107.80 ± 17.81	9.98± 1.98	7.78 ± 3.01
	Mean Values		110.39 ± 19.21	9.35 ± 2.01	5.21 ± 2.56
	UNSCEAR [14]		10	0.1	1.0

For ^{40}K radionuclide, BH4 and BH14 (189.01± 21.29 and 189.01.±31.29 B_q L^{-1}) have the highest activity concentration of potassium (^{40}K) radionuclide, the second is BH10 (168.74±15.06 B_q L^{-1}), the third is BH17 (132.71±18.40 B_q L^{-1}), the fourth are (BH9 and BH7 (128.01±23.78 and 127.18± 24.01 B_q L^{-1}), the fifth are BH13 and BH19 (110.84±14.18 and 107.80±12.81 B_q L^{-1}), the sixth are BH5 and BH15 (102.75±17,51 and 102.75±31.86 B_q L^{-1}), the seventh are BH1 and BH11 (99.80±15.31 B_q L^{-1} each), the eighth are BH2 and BH12 (98.99±22.09 B_q L^{-1} each), others in this position are BH3, BH16, BH18 and BH8 (98.49±14.58, 98.21±16.00, 98.44±13.90 and 94.41±13.39 B_q L^{-1}) and the borehole that has the least activity concentration is BH6 (82.13±23.60 B_q L^{-1}). All the obtained values are higher than the world average recommended values 10 B_q L^{-1} [14], as shown in Fig. 2.

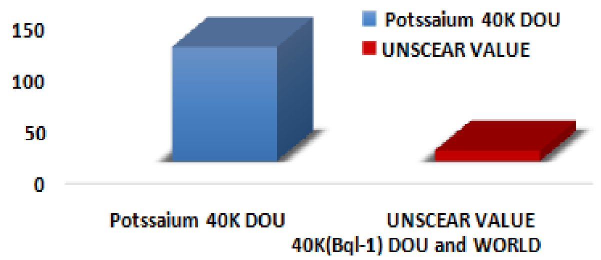

Figure 2: Comparison of the mean values of ^{40}K (Bql^{-1}) in all sample points with the world recommended value

For ^{238}U the borehole that has the highest activity concentrations are BH15, BH18 and BH3 (11.78±3.86, 11.38±1.89 and 11.34±2.94 B_q L^{-1}), the second is BH14 (10.56±2.10 B_q L^{-1}), the third are BH9 and BH19 (9.98±1.98 B_q L^{-1} each), BH2 and BH12 (9.59±3.70 B_q L^{-1} each), BH8 and BH4 (9.38±1.89 and 9.35±2.10 B_q L^{-1}), the fourth are BH5, BH10, BH7 and BH13 (8.78±1.86, 8.57±2.09, 8.32±2.98 and 8.34±2.94 B_q L^{-1}), the fifth are BH1, BH11 and BH17 (7.34±4.12, 7.34±2.12 and 7.32±1.78 B_q L^{-1}) and the boreholes that have the least activity concentrations are BH6 and BH16 (6.76±1.11 and 6.76±2.11 B_q L^{-1}). All the obtained values are higher than the world average recommended values 0.1 B_q L^{-1} [14], as shown in Fig. 3.

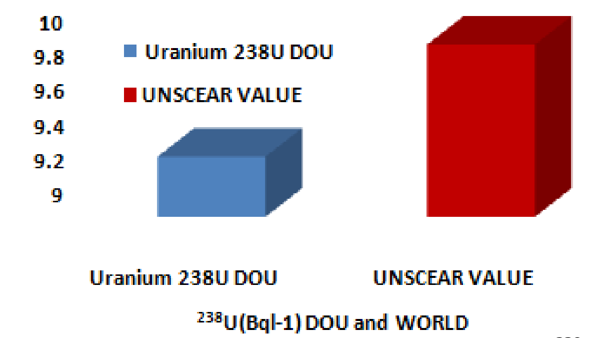

Figure 3: Comparison of the mean values of ^{238}U (Bql^{-1}) in all sample points with the world recommended value

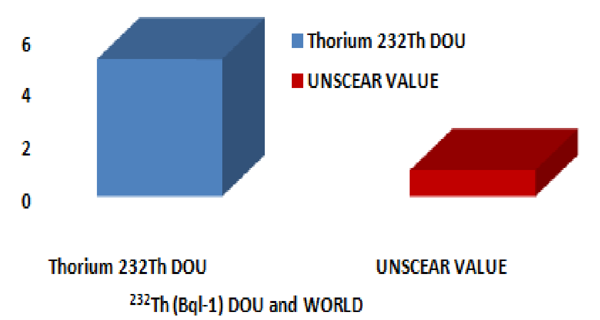

Figure 4: Comparison of the mean values of ^{232}Th (Bql^{-1}) in all sample points with the world recommended value

For ^{232}Th the borehole that has the highest activity concentrations are BH18, BH15 and BH8 (9.98±2.23, 9.43±2.16 and 9.08±2.33 B_q L^{-1}), the second is BH14 (8.79±3.00 B_q L^{-1}), the third are BH9 and BH19 (7.78±3.01 B_q L^{-1} each), BH7 (7.21±3.04 B_q L^{-1}), the fourth are BH10, BH4, BH3 and BH13 (6.89±1.51, 6.79±3.00 and 6.14±2.09 B_q L^{-1}) (BH3 and BH13 each), the fifth are BH2, BH5, BH11 and BH17 (5.98±2.11, 5.63±2.16, 5.56±1.02 and 5.02±2.04 B_q L^{-1}) and the boreholes that have the least activity concentrations are BH12, BH1, BH6 and BH16 (4.98±1.11, 4.56±1.32, 4.20±2.03 and 4.20±1.38 B_q L^{-1}). All the obtained values are higher than the world average recommended values 1.0 B_q L^{-1} [14] as showed in Fig. 4.

This work examined the activity concentration of ^{40}K, ^{238}U and ^{232}Th in drinking water sourced from boreholes in Dennis Osadebay University, Asaba Delta State Nigeria. It is of imperative importance health-wise on humans and animals to know the level and ascertain the safe level of radionuclides in drinking and bathing water sources. This was in line with the motive of some workers [15, 16] when they examined the radionuclide in drinking water in tin mine area in North-Western Nigeria. This is because these water sources may contain high level of radionuclides which are toxic to the physiology of animals and humans using the water especially for drinking. The reason of this research is also associated with the work of [17] that a person who drinks radionuclide contaminated water sources over a 70-year period has a cumulative cancer risk. Twenty nine sampleswere collected from different boreholes water sources within the perimeter of Dennis Osadebay University, Asaba Delta State and is use for drinking and other domestic activities. Here is a mean summary of the results.

The summary of the activity concentration of the radionuclides are; ^{40}K ranges from 189.01± 21.29 Bq L^{-1} (BH4 and BH14) to 82.13±23.60 Bq L^{-1} (BH6), that of ^{238}U ranges from 11.78±3.86 Bq L^{-1} (BH15, BH18 and BH3) to 6.76±1.11 Bq L^{-1} (BH6 and BH16) and that of ^{232}Th ranges from 9.98±2.23 Bq L^{-1} (BH18, BH15 and BH8) to 4.98±1.11 Bq L^{-1} (BH12, BH1, BH6 and BH16). Based on the result of the analysis, it was clearly indicated that the activity concentration of ^{40}K ranked first, secondly to ^{238}U and thirdly to ^{232}Th, respectively. This agreed with the findings of some workers [18, 19] on their research where they found that ^{40}K had the highest activity concentration, followed by ^{232}Th and lastly by ^{238}U. The World Health Organization [20] recommendation limit for ^{232}Th in drinking water is 0.1 Bq/L while the UNSCEAR [14] guideline for ^{40}K is 10 Bq/L. The results of ^{232}Th and ^{40}K surpassed the recommended values of the two world organizations recommendation of the radionuclides in drinking water. This is an indication that the borehole water in Dennis Osadebe University and it environ is not fit for domestic activity especially for drinking due to the high activity concentration of ^{232}Th and ^{40}K. This is totally contrary to the findings reported by some researchers [13, 21] when they studied the presence of radionuclides in drinking water in Epe, secondary schools, Lagos. This is because the continuous consumption of water that has sublethal activity concentration of ^{40}K, ^{238}U and ^{232}Th may lead to chronic health complication in human and animals in future. Therefore, the borehole water should be treated before consumption. Fig. 5 shows the relative contribution of radionuclides in water. Table 2 provides a comparative activity natural occurring radionuclides in the water samples with other findings.

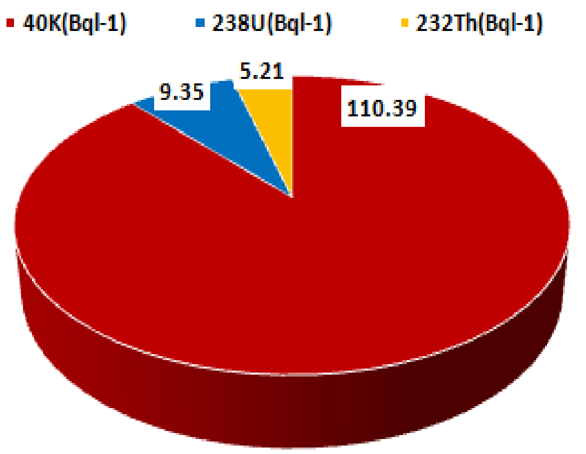

Figure 5: Relative contribution of radionuclides from total natural radiation in the studied water samples

Table 2: Comparison of the mean activity concentrations of radionuclides in water samples to that obtained from other regions

Country	^{40}K(Bql^{-1})	^{238}U(Bql^{-1})	^{232}Th(Bql^{-1})	Ref.	Water Source
Iraq (Kirkuk)	1.09	0.122	0.08	[22]	Tap water
Turkey	4.3	0.4	0.5	[23]	Bottled mineral water
Nigeria (Oil producing areas, Delta State).	49 ± 15	3 ± 1	3 ± 2	[24]	Well, tap and surface water
Nigeria (Eko-Ende dam, Osun State).	521.59±11.05	36.73± 1.44	52.05 ± 5.88	[25]	Dam
Nigeria (Ogbomosho, Oyo State).	100.13±26.82	6.03±2.10	5.54±1.76	[26]	Stream
Nigeria (Iron and Steel smelting region, Fashina, Osun State).	89.41 ± 24.15	8.56 ± 2.80	13.17 ± 4.48	[27]	Borehole and well
Nigeria (Epe, Lagos State)	13.4 + 10.8	6.0 ± 1.4	4.5 ±1.2	[13]	Well
Dennis Osadebe University, Anwar, Asaba, (Delta State, Nigeria)	110.39± 19.21	9.35 ± 2.01	5.21 ± 2.56	P.S.	(DOU) Bore-hole Water

P.S. = Present Study

According to the European Directive [28], the levels of ^{40}K need not be considered in assessing health risks from radionuclides in drinking water. This is because potassium is a fundamental element that regulates many body functions. If this is internationally accepted, does itmeans that the consumption of ^{40}K at high dosage in drinking water persistently will not result to chronic physiological issues in man and animal? However, UNSCEAR [14] recommend 10 Bq/L for ^{40}K in drinking water.

In comparison of the result of ^{40}K from this research to the recommendation value of UNSCEAR [14], it will be concluded consumption of drinking water that contain 10 Bq/L of ^{40}K is not safe for consumption. Therefore, the consumption of borehole water in Dennis Osadebay University and it environ is not safe. Here is a distribution chart showing radiation burden of the borehole in the study area.

Conclusion

It can be concluded that the borehole water in Dennis Osadebay University and its environs has high activity concentration of ^{40}K, ^{238}U and ^{232}Th, and the level of activity concentrations are above the recommended limit of WHO and UNSCEAR. Thus, the drinking of the borehole water should be discouraged due to the health effect associated with radionuclides. We there by recommend that Epidemiological study should be carried out to check the level of radionuclide intoxication and the water should be treated or screened of radionuclide before use.

Conflict of interest: The authors declare that there isno conflict of interest.

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References

[1] Esi, E. O., Akpoyibo, O., Nwankwo, R. C. & Vwavware, O. J. (2023). Estimation of the variability of sand deposits in chosen communities in parts of Niger Delta, Southern-Nigeria using geophysical techniques. *Solid Earth Sciences* 8, 267–282. https://doi.org/10.1016/j.sesci.2023.10.001

[2] Ikeda, N., Hasegawa, T. & Fukuda, M. (2020). Accumulation and effects of radionuclides in aquatic organisms. *Environmental Science & Technology*, 54(7), 4321-4329.

[3] Rabiu, J. A., Kolawole, A. A., Raheem, I. O. & Junaidu, A. H. (2025). Determination of radionuclide concentration and its health effect in fish samples from Dadin Kowa Dam, Gombe State, Nigeria. *Dutse Journal of Pure and Applied Science*, 11(1c), 250-262. https://dx.doi.org/10.4314/dujopas.v11i1c.25

[4] Esi, O. E., Agbalagba, E. O. & Avwiri, G O. (2021). Impact of produced water discharge on the gross alpha and gross beta activity concentrations and radiological health risk on drinking water sources in coastal areas of Nigeria. *Int. J. Ambient Energy*, 42(1), 18-28. https://doi.org/10.1080/01430750.2018.1525577

[5] Orosun, M. M., Ehi-Eromosele, C. O. & Oguntimehin, I. I. (2022). Overview of radionuclides: Sources and impacts. *Radiation Protection Dosimetry*, 190(2), 114-123.

[6] Paul, S. N., Frazzoli, C., Sikoki, F. D., Babatunde, B. B. & Orisakwe, O. E. (2022). Natural occurring radioactive materials (NORMs) from mining sites in Nigeria: A systematic review of geographical distribution and public health concern. *Journal of Environmental Radioactivity*, 249, 106889. https://doi.org/10.1016/j.jenvrad.2022.106889

[7] Mohuba, S. C., Abiye, T. & Nhleko, S. (2022). Evaluation of radionuclide levels in drinking water from communities near active and abandoned gold mines and tailings in the West Rand Region, Gauteng, South Africa. *Minerals*, 12(11), 1370. https://doi.org/10.3390/min12111370

[8] Giussani, A., Lopez, M. A., Romm, H., Testa, A., Ainsbury, E. A., Degteva, M. & Youngman, M. (2020). Eurados review of retrospective dosimetry techniques for internal exposures to ionising radiation and their applications. *Radiation and Env. Biophysics*, 59, 357-387. https://doi.org/10.1007/s00411-020-00845-y

[9] Eckerman, K., Harrison J., Menzel H.-G., Clement, C. H., Fasunwon, O. O., Alausa, S. K., Odunaike, R. K., Alausa, I. M. & Ajala, B.I. (2010). Activity concentrations of natural radionuclide in well waters of Ago-Iwoye, Nigeria. *Iran J. of Radiation Res.*, 7(4), 207-210. https://doi.org/10.1016/j.icrp.2013.05.003

[10] Kugbere, E., Isi, P. O., Amidu, O. M., Adewole, M. G. & Victor M. (2025). Assessment of activity concentrations of radionuclides (^{226}Ra, ^{232}Th and ^{40}K) and annual effective doses in water from gold mining pits, Osun State, Nigeria. *Int. J. of Life Sci. Res.*, 13(2), 41-47. https://doi.org/10.5281/zenodo.15268629

[11] Pandey, B. N., Kumar, A., Tiwari, P. & Mishra, K. P. (2010). Radiobiological basis in management of accidental radiation exposure. *Int. J. of Radiation Biology*, 86(8), 613-635. https://doi.org/10.3109/09553001003746059

[12] Esi, E. O. & Akpoyibo, O. (2024). Geophysical survey and radiometric assessment of aquifer strata and vulnerable groundwater quality of Ukwuani Ommunities in Delta State. *Scientia Africana*, 23(2), 88-103. https://doi.org/10.4314/sa.v23i2.9

[13] Oyebanjo, O. A. & Magbagbeola, A. G. (2015). Radionuclide analysis of drinking water in selected secondary schools of Epe local government area, Lagos state, Nigeria. *Nigeria J. of Pure & Applied Physics*, 6(1), 40 – 45.

[14] UNSCEAR (2000). Report to the General Assembly. Annex B: Exposures from Natural Radiation Sources (New York).

[15] Abdu, N. M., Aznan, F. I. & Nuraddeen, N. G. (2022). Annual effective dose associated with radioactivity in drinking water from tin mining areas in North-western Nigeria. *J. of Radiation Research and Applied Sciences*, 15(3), 96-102. https://doi.org/10.1016/j.jrras.2022.06.008

[16] Esi, E. O., Edomi, O. & Odedede, P. O. (2019). Assessment of indoor and outdoor background ionizing radiation level in School of Marine Technology, Burutu, Delta State, Nigeria. *Asian Journal of Research and Reviews in Physics*, 2(3), 1-8. https://doi.org/10.9734/ajr2p/2019/v2i330104

[17] Karabıdak, S. M., Kaya, A. & Kaya. S. (2019). Cancer risk analysis of some drinking water resources in Gümüşhane, Turkey, Sustain. *Water Resources Management*, 5, 1939–1949. https://doi.org/10.1007/s40899-019-00338-x

[18] Gezim, H., Serdar, D., Sehad, K., Sami, M. & Labinot, K. (2025). Natural radionuclides in drinking water and annual effective dose to infant, child, and adult. *Journal of Water and Health*, 23(3), 373–383. https://doi.org/10.2166/wh.2025.316

[19] Dizman, S., Aşık, F. Z., Özçelik, A. E., Keser, R. & Görür F. K. (2023). Tritium contents in drinking and surface seawaters before the nuclear power plant planned in Sinop (Türkiye) and their radiological risks on human population. *J. of Water Health*, 21, 1847–1857. https://doi.org/10.2166/wh.2023.205

[20] WHO (2000). Guidelines Drinking-water Quality: Recommendations. World Health Organization, Geneva.

[21] Esi, E. O. & Akpoyibo, O. (2023). Estimation of aqufer transmissivity for typical oil producing communities of western Niger Delta using electrical resistivity survey. *Coast J. of the School of Sci. Oaustech Okitipupa,* 5(2), 893-908. https://doi.org/10.61281/coastjss.v5i2.2

[22] NajebaSalih, F. (2022). Measuring the radioactivity concentration of ^{40}K, ^{226}Ra, ^{232}Th and radiological risk assessment from water tap. *J. of Envtal Protection,* 10, 353-358. https://doi.org/10.21203/rs.3.rs-1878168/v1

[23] Altikulac, A. (2022). Natural radionuclides in bottled mineral waters consumed in Turkey and their contributions to radiation dose. *J. of Environmental Chemistry,* 7, 34428-34435. https://pubs.acs.org/10.1021/acsomega.2c04087

[24] Tchokossa, P. (2011). Assessment of radionuclide concentrations and absorbed dose from consumption of community water supplies in oil and gas producing areas in Delta State, Nigeria. *World Journal of Nuclear Science and Technology*, 1, 77-86. https://doi.org/10.4236/wjnst.2011.13012

[25] Ogundele, K. T. & Oluyemi, E. A. (2020). Determination of radionuclide concentrations and hazard indices of water and fish in Eko-Ende Dam, Ifelodun Local Government Area, Osun State, Nigeria. *Journal of Radiation and Nuclear Applications* 5(1), 55-59. https://doi.org/10.18576/jrna/050108

[26] Ayaji, N. O. & Laogun, A. A. (2006). Variation of environmental gamma radiation in Benin with vertical height. *Nig. J. Space Res*., 2, 47–54.

[27] Oluyide, S. O., Tchokossa, P., Orosun, M. M. & Akinyose, F. C. (2019). Natural radioactivity and radiological impact assessment of soil, food and water around iron and steel smelting area in Fashina Village, Ile-Ife, Osun State, Nigeria. *J. Appl. Sci. Env. Mgt.,* 23(1), 135–143. https://dx.doi.org/10.4314/jasem.v23i1.20

[28] European Council (2013). Council Directive 2013/51/Euratom of 22 October 2013 on the protection of the health of the general public with regard to radioactive substances in water intended for human consumption, *Official Journal of the European Union* L 296, 12–21.

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